Consiglio Nazionale delle Ricerche
Istituto di Scienze delle Produzioni Alimentari
ISPA Sede di Milano
Via Celoria, 2 - 20133 Milano (Italy)
Tel. + 39 02 50316685
Fax + 39 02 50316687

8th Summer Academy
of EURACADEMY ASSOCIATION
The European Academy of Sustainable Rural Development
San Marco dei Cavoti, Benevento, Italy
18th –26th July 2009

Redefining Food Quality

ISPA

Roberta Lodi

CNR- ISPA
Milano

Consiglio Nazionale delle Ricerche

National Research Council

Istituto di Scienze delle Produzioni Alimentari ISPA

Institute of Sciences of Food Production

Sede di Milano

Milan, Italy

Food Quality

???

Food Quality

↓

the quality characteristics of food

<u>acceptable</u> to consumers

This includes:

- external factors as appearance (size, shape, colour, gloss, and consistency), texture, and flavour;
- internal factors (chemical, physical, microbial);
- factors such as legal standards

For many consumers:

to know what ingredients are present, due to:

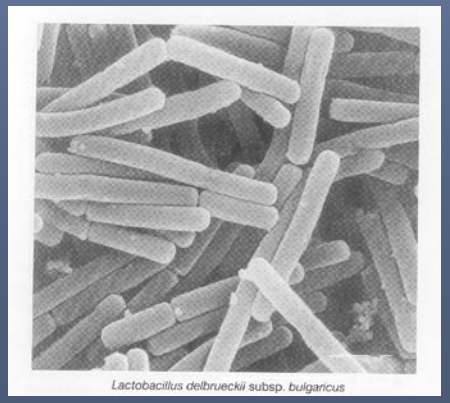
- dietary, nutritional requirements (kosher, halal, vegetarian)
- medical conditions (e.g., diabetes, or allergies)

Food quality also deals with:

- product traceability,
- ingredient and packaging suppliers,
- labeling issues to ensure there is correct ingredient and nutritional information

CNR- ISPA
Milano

- Hygienic quality
- Nutritional quality
- Sensorial quality

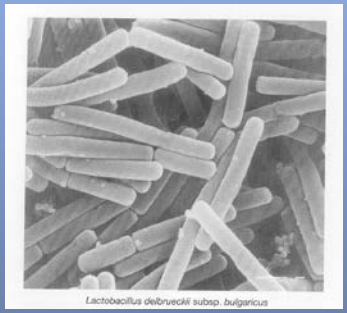


Lactobacillus delbrueckii subsp. *bulgaricus*

CNR- ISPA
Milano

SAFETY

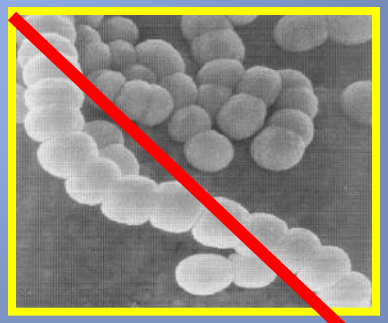
Preventive and control strategies for pathogenic microorganisms in the food production chain

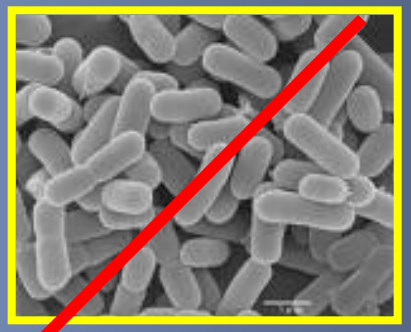


- Factors affecting microbial growth
- Growth parameters of pathogenic microorganisms

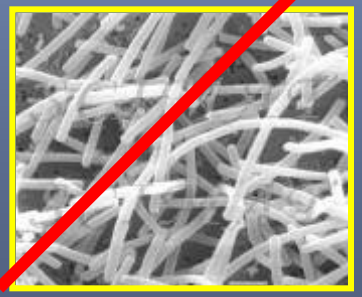
CNR- ISPA
Milano

Why microbiology?



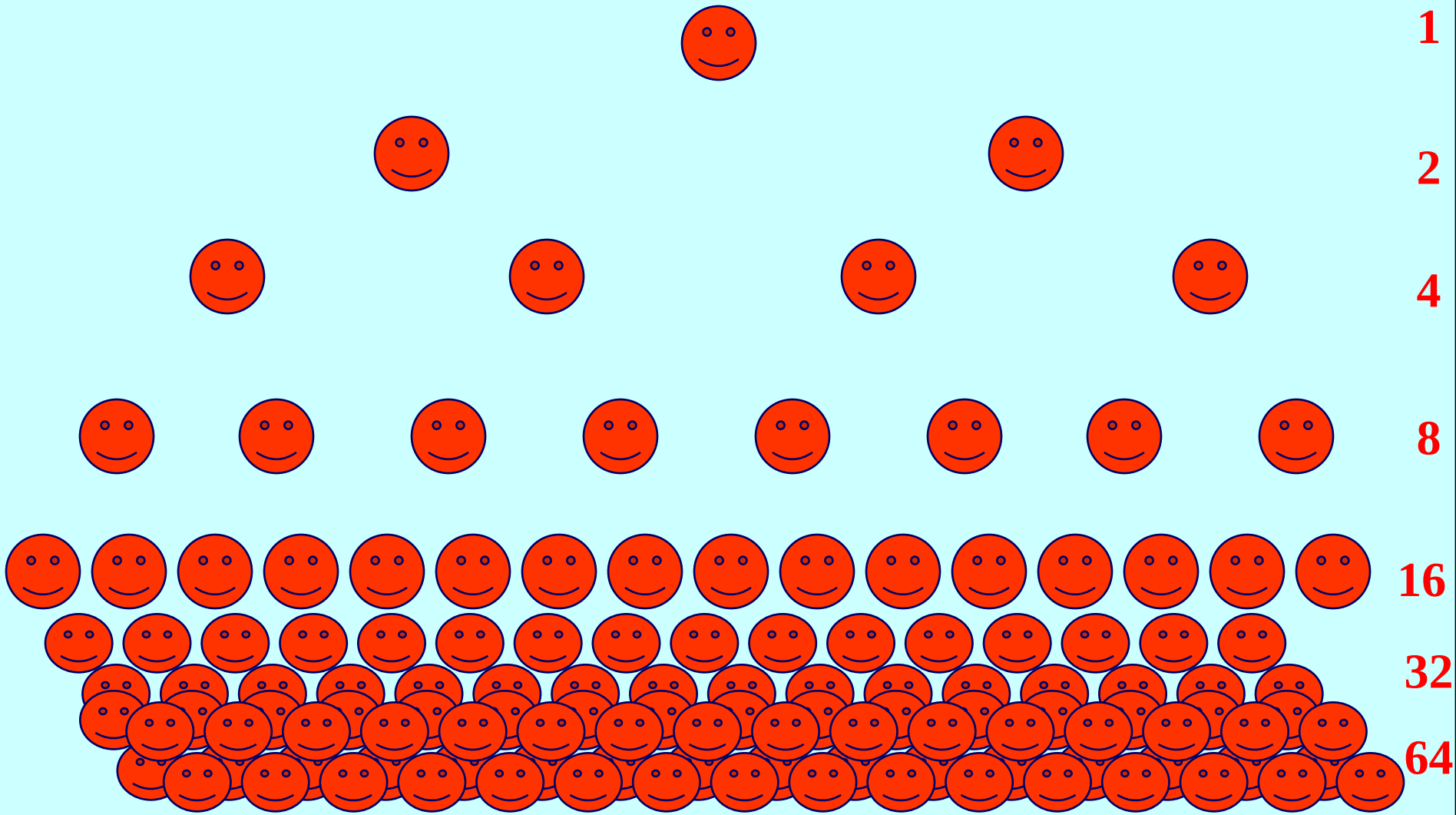


Safety - sterility?



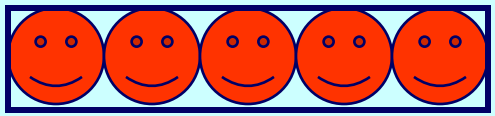
CNR- ISPA
Milano

Bacterial growth



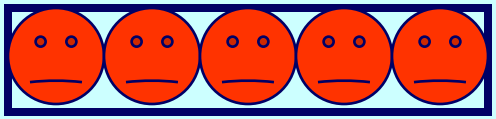
CNR- ISPA
Milano

optimum



1 → 64 cells
2 hours

not optimum



1 → 64 cells
6 hours

Bacterial growth

CNR- ISPA
Milano

Factors affecting growth and survival of micro-organisms

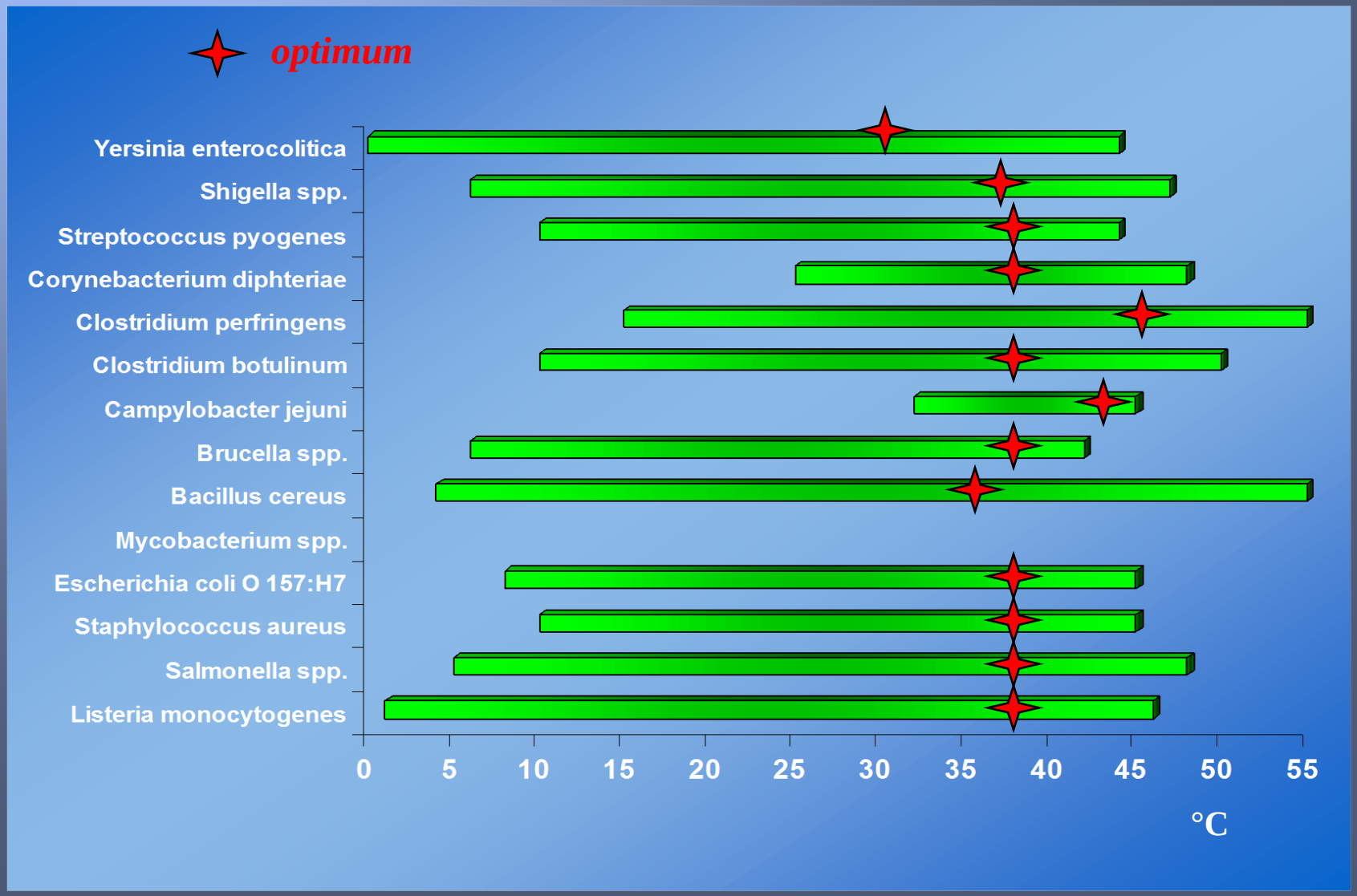
Nutrient content

Temperature

Growth parameters

CNR- ISPA
Milano

Growth parameters of food pathogens : **temperature**



CNR- ISPA
Milano

Factors affecting growth and survival of micro-organisms

Nutrient content

Temperature

pH

Growth parameters

CNR- ISPA
Milano

Factors affecting microbial growth

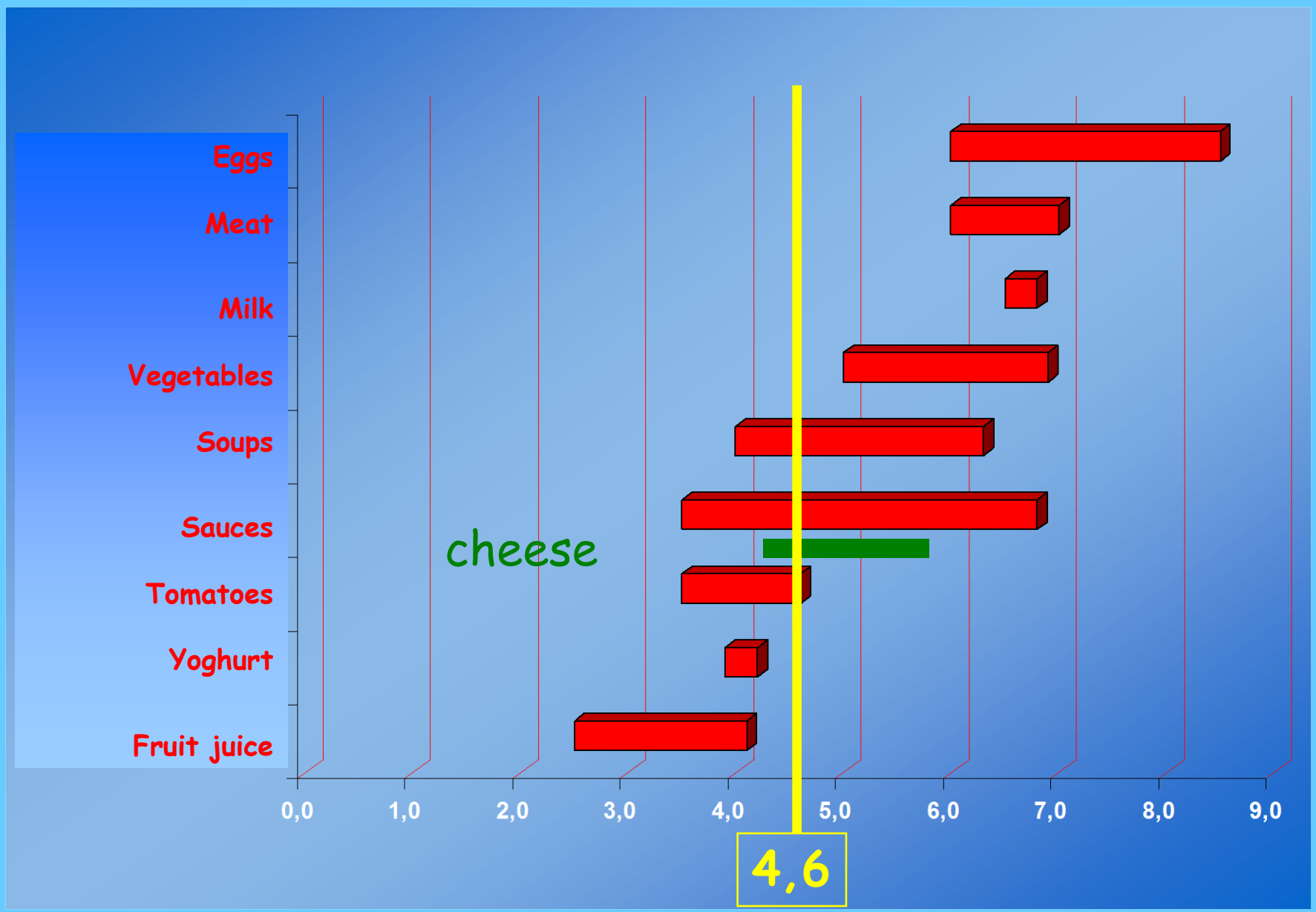
pH / growth

	pH OF GROWTH		
MICRO-ORGANISMS	MINIMUM	OPTIMUM	MAXIMUM
Bacteria			
Staphylococcus	**4.0**	**6.8 – 7.5**	**9.8**
Streptococcus	**4.3**		**9.3**
Lactobacillus	**3.0**	**5.5 - 6**	**8**
E.coli	**4.3**	**6.0 – 8.0**	**9 - 10**
Salmonella	**4.5**	**6.0 – 7.5**	**8 - 9**
Lieviti Yeasts	**2 – 2.5**	**4.0 – 6.5**	**8 - 10**
Muffe Moulds	**1.5 - 2**	**4 - 7**	**9 - 11**

CNR- ISPA
Milano

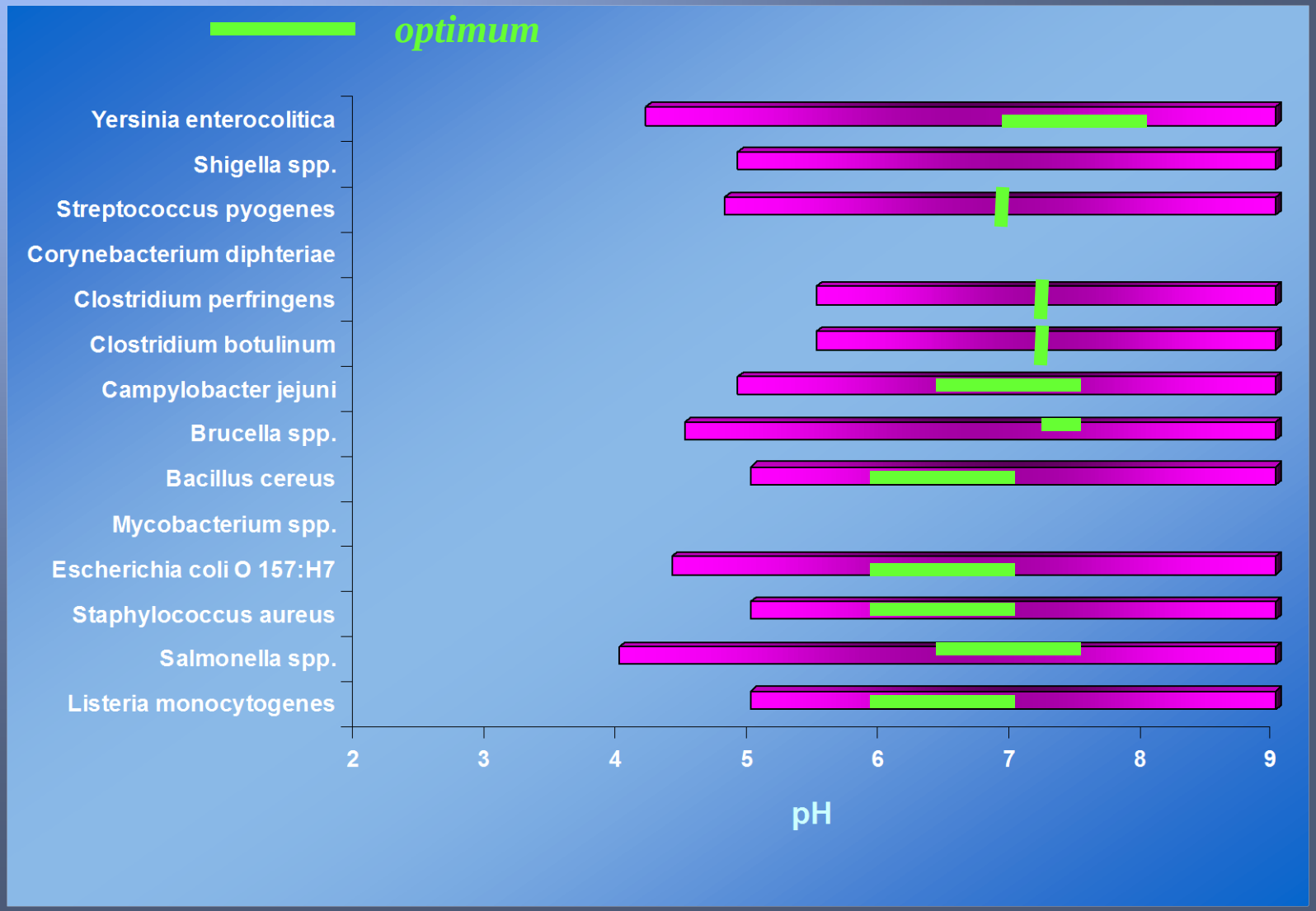
Food

high acidity low acidity



CNR- ISPA
Milano

Growth parameters of food pathogens: **pH**



CNR- ISPA
Milano

Factors affecting growth and survival of micro-organisms

Nutrient content

Temperature

pH

Water activity a_w

Growth parameters

Water activity (a_w) :

"the ratio of the partial pressure of water in the atmosphere in equilibrium with the substrate, compared with the partial pressure of the atmosphere in equilibrium with pure water at the same temperature"

⬇

water available for microbial enzymes

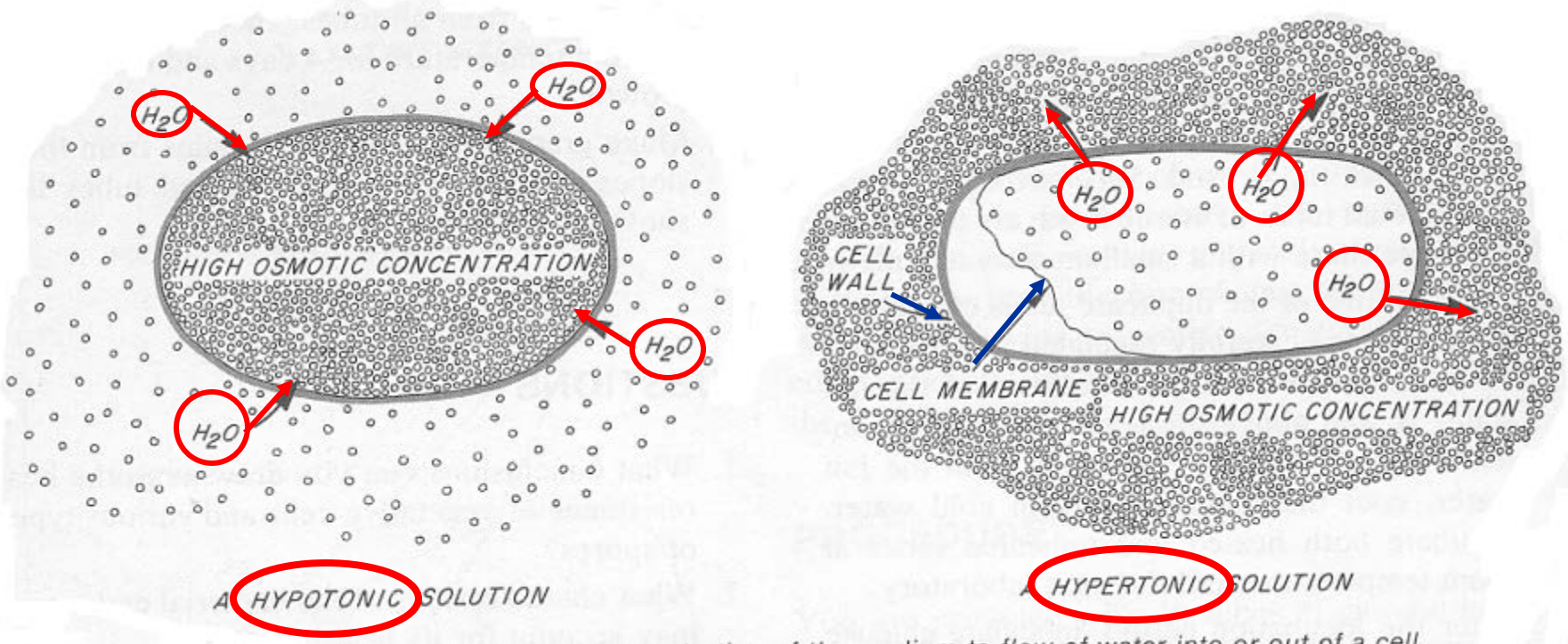
Water activity (a_w)

halotolerant → able to grow in the presence of high concentration of salt

osmotolerant → able to grow in the presence of high concentration of unionized organic compounds such as sugars

xerotolerant → able to grow on dry foods

CNR- ISPA
Milano



Relation of osmotic concentration of the medium to flow of water into or out of a cell.

CNR- ISPA
Milano

a_w

Range of a_w	Micro-organisms inhibited	Examples
1.00 – 0.95	Most Gram– rods Bacterial spores (germination) Some yeasts	Foods 40% sugar or 7% salt
0.95 – 0.91	Most Cocci Lactobacilli *Bacillaceae* (vegetative) Some moulds	Foods 55% sugar 12% salt (ex. soft cheeses)
0.91 – 0.87	Most yeasts	Foods 65% sugar or 15% salt (ex. hard cheeses)
0.87 – 0.80	Most moulds *Staphylococccus aureus*	Foods: 15-17% water (ex. condensed sugared milk)
0.80 – 0.75	Most halophilic bacteria	Foods: 26% salt
0.65 – 0.60	Xerophilic fungi	Foods: ~ 8% water
0.50	No growth	
0.40		
0.30		~ 5% water
0.20		2-3% water

Fresh vegetables, meat, milk, fish

Cured meats, ham, Salami

Dry cheeses, flour cakes, beans, cereals

Pickles, jams

Dried fruits, caramels

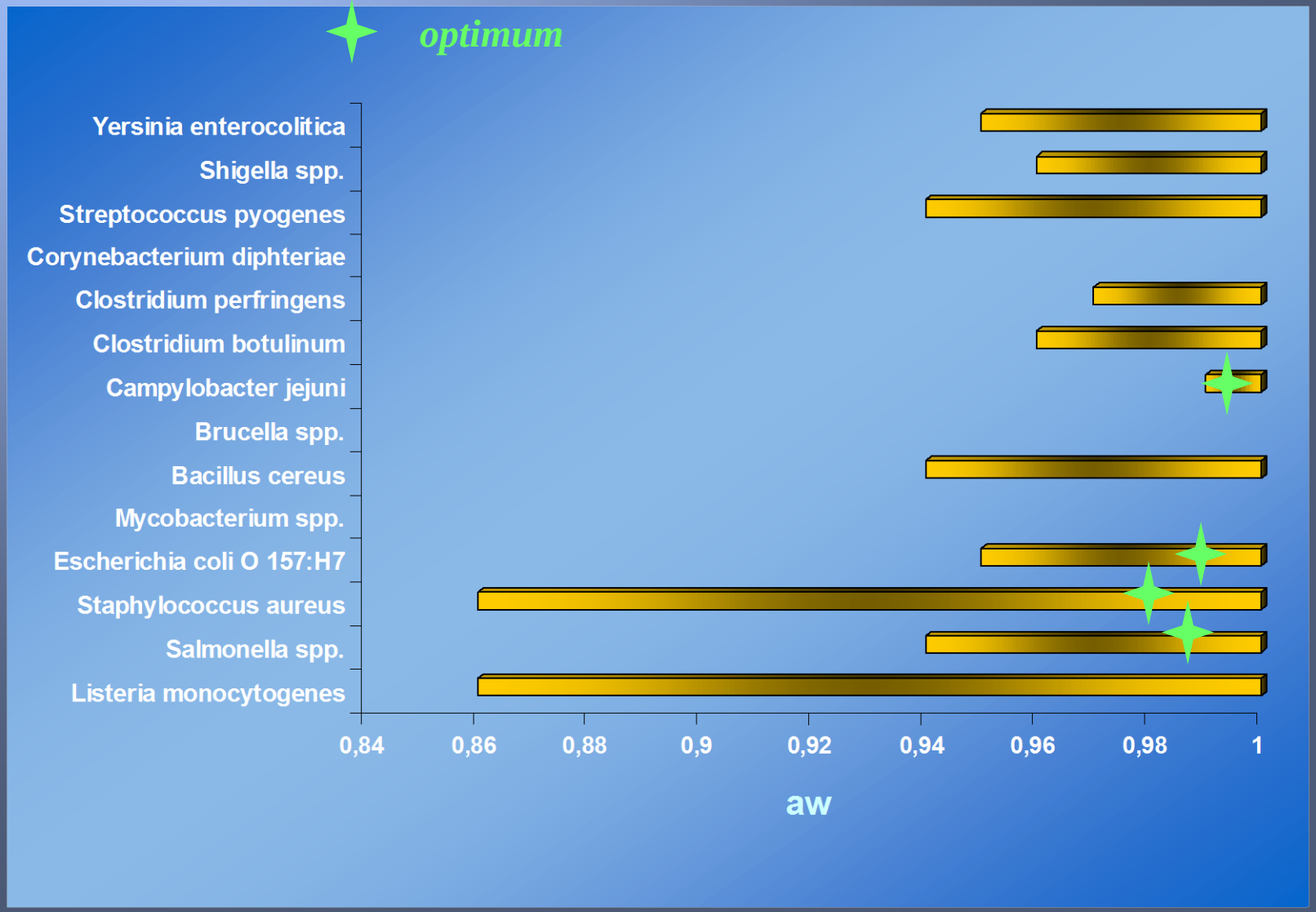
Dehydrated foods

a_w

Group of micro-organisms	Minimum a_w
Most Gram-negative bacteria	0,97
Most Gram-positive bacteria	0,90
Most yeasts	0,88
Most filamentous fungi	0,80
Halophilic bacteria	0,75
Xerophilic fungi	0,61

CNR- ISPA
Milano

Growth parameters of food pathogens: **water activity**



CNR- ISPA
Milano

Factors affecting growth and survival of micro-organisms

Nutrient content

Temperature

Redox Potential Eh

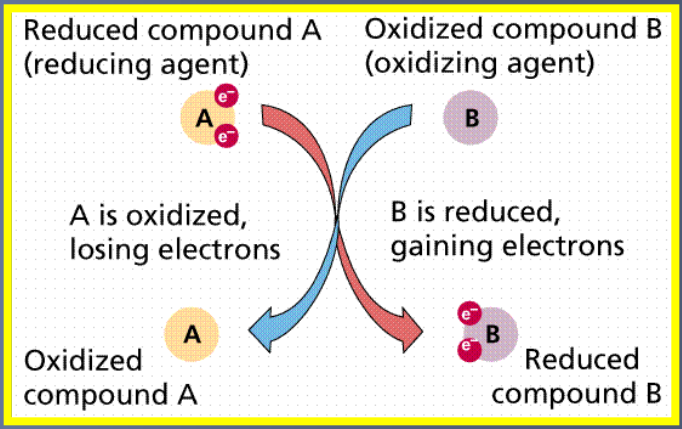
pH

Water activity a_w

Growth parameters

The redox potential (Eh)

Eh is a measure of the ability of a chemical/biochemical system to oxidise (lose electrons) or reduce (gain electrons)

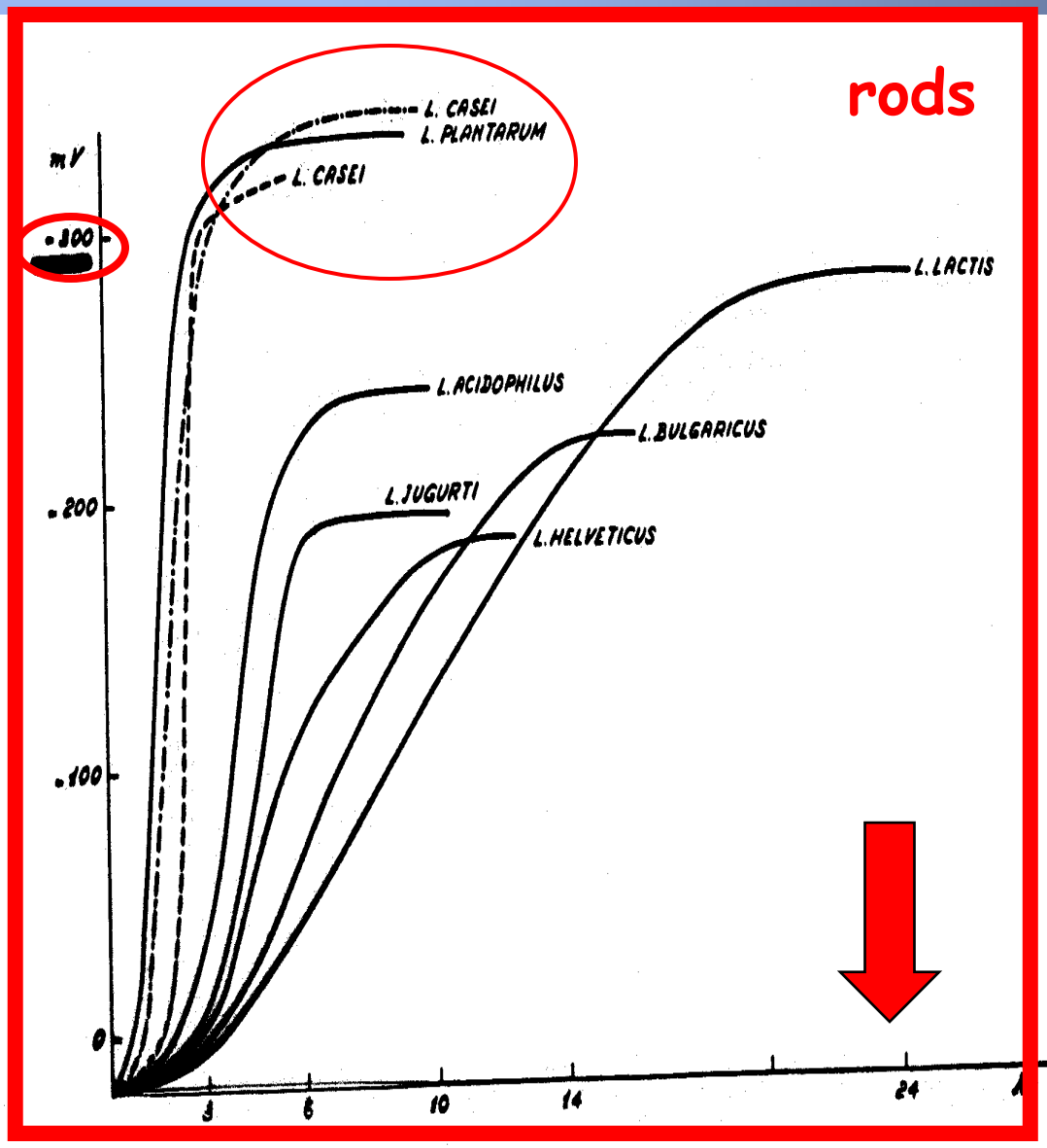


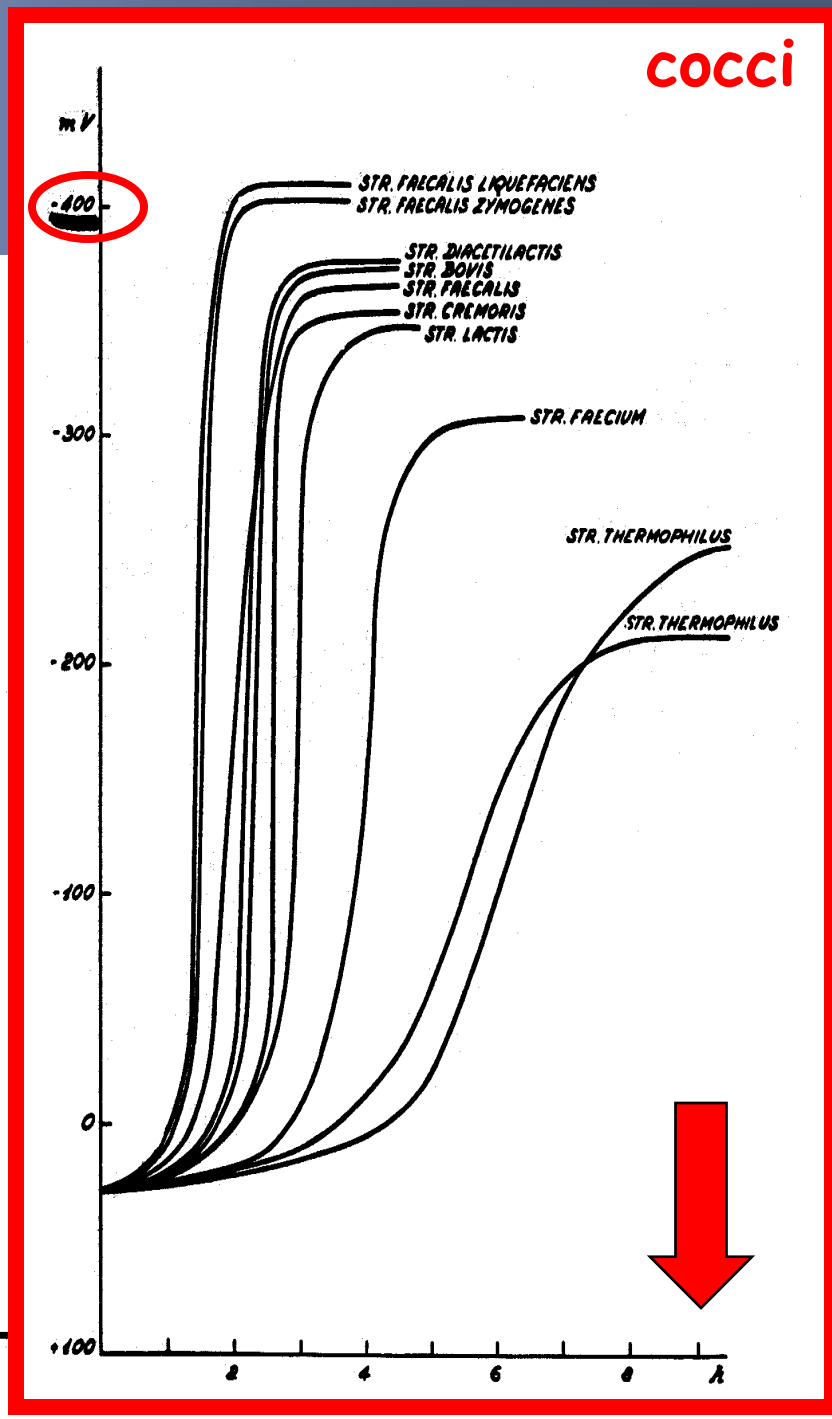
- Eh of fresh milk: +150 mV
- Eh of some cheeses: < -250 mV

The exact mechanism of the reduction power in cheese is related to fermentation of sugars to lactic acid by LAB (Cachon et al 2002).

CNR- ISPA
Milano

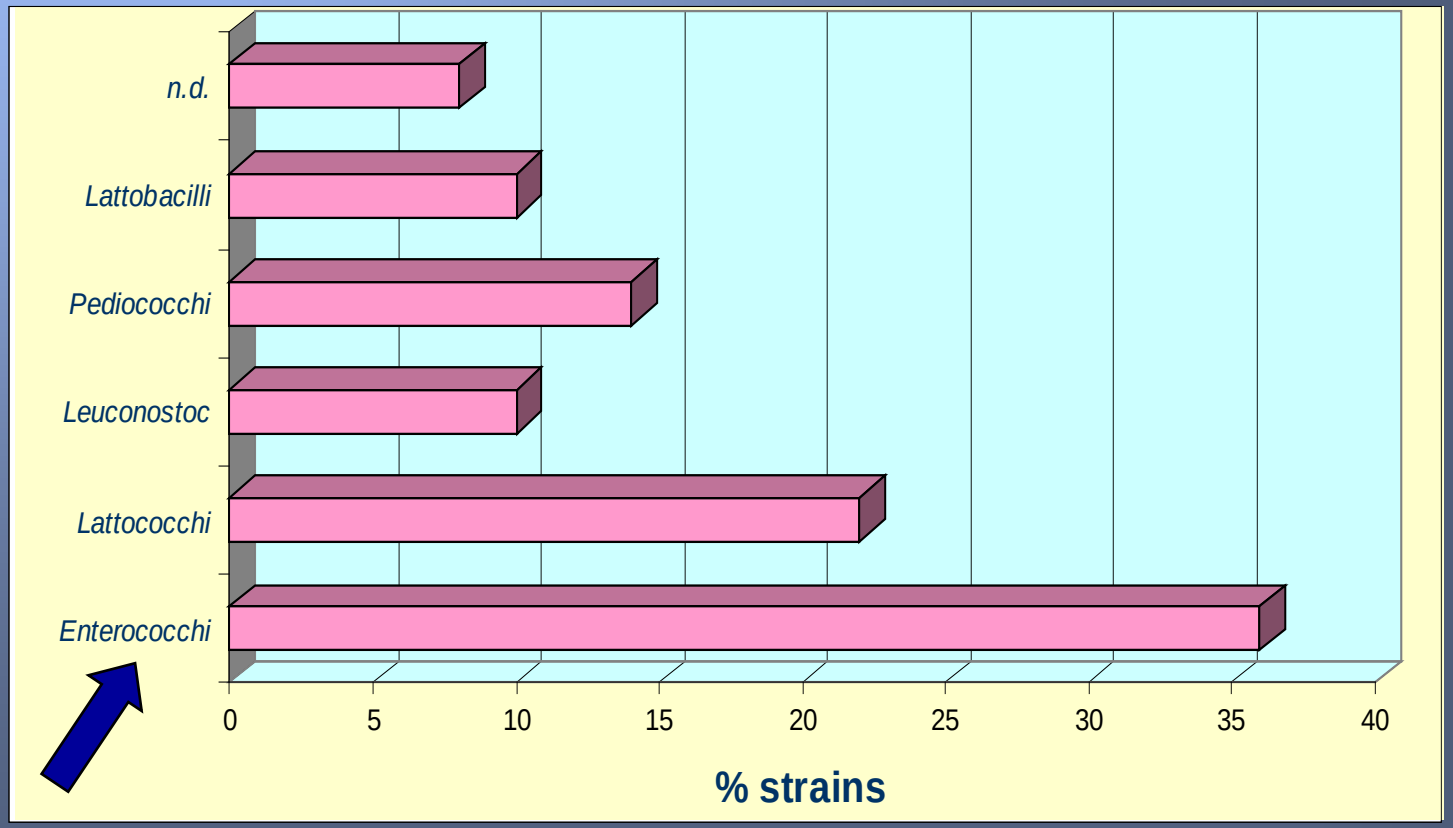
Redox





CNR- ISPA
Milano

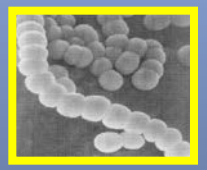
Lactic acid bacteria strong reducing



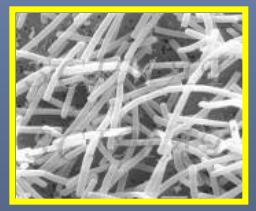
CNR- ISPA
Milano

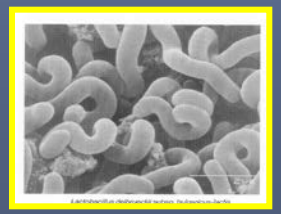
and now

a joke !!!

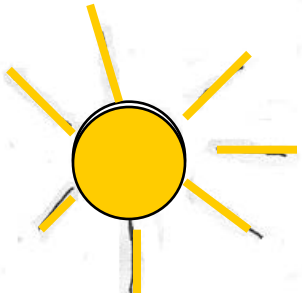


microbial race

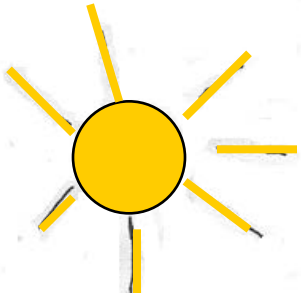


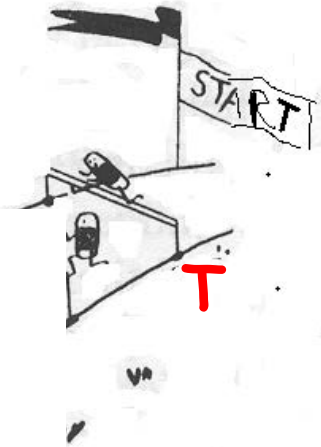


The hurdle effect
La corsa ad ostacoli

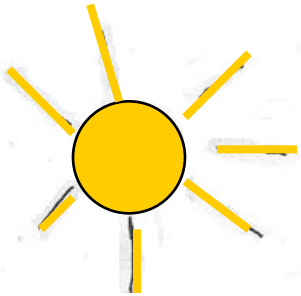


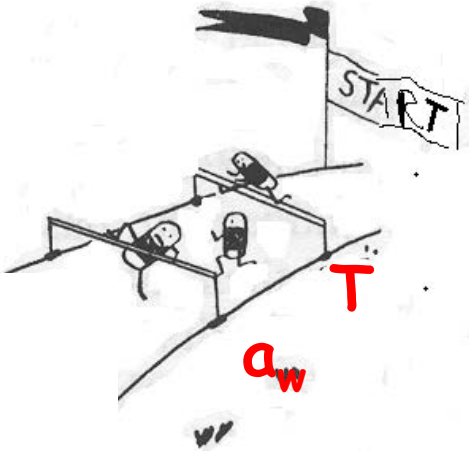
The hurdle effect
La corsa ad ostacoli



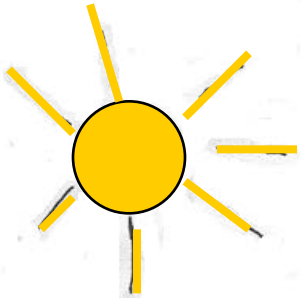


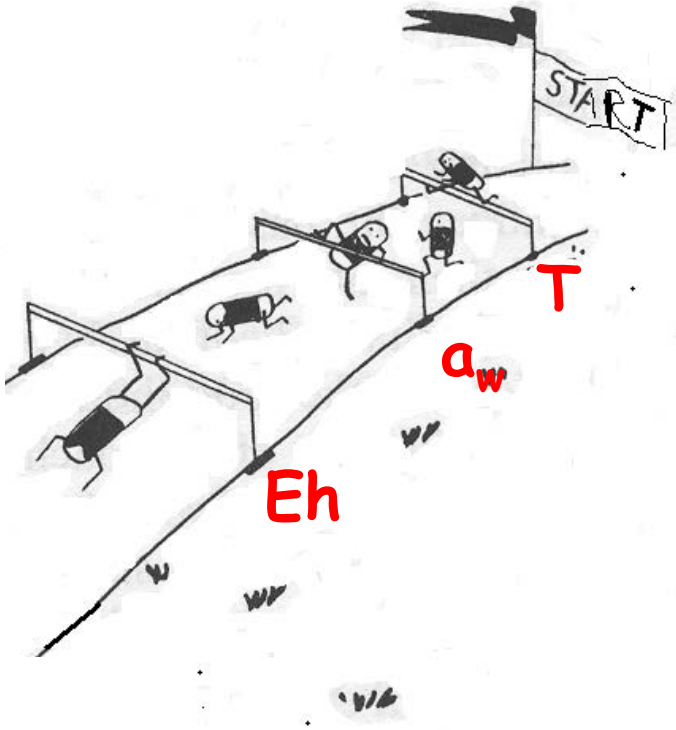
The hurdle effect
La corsa ad ostacoli



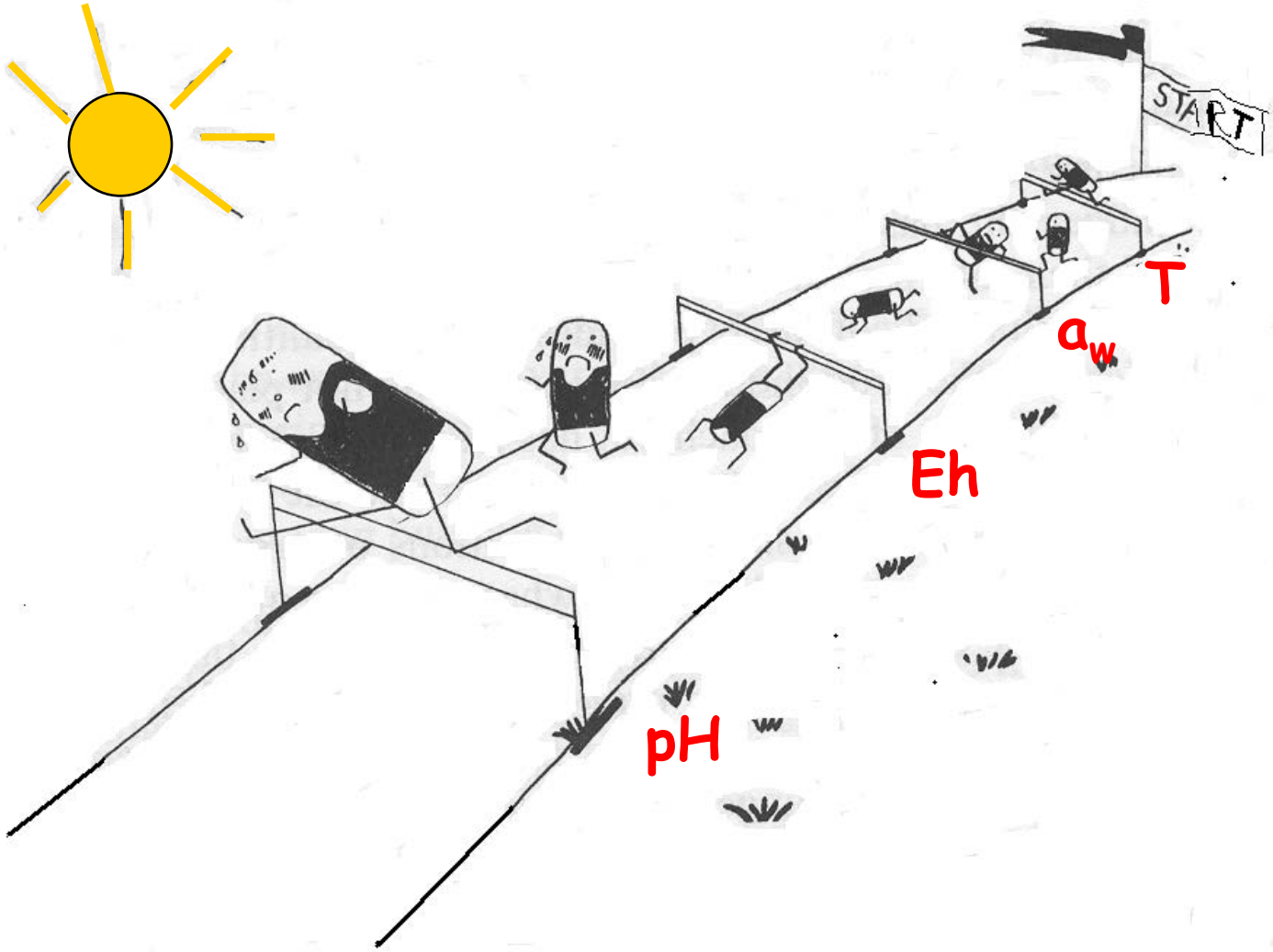


The hurdle effect

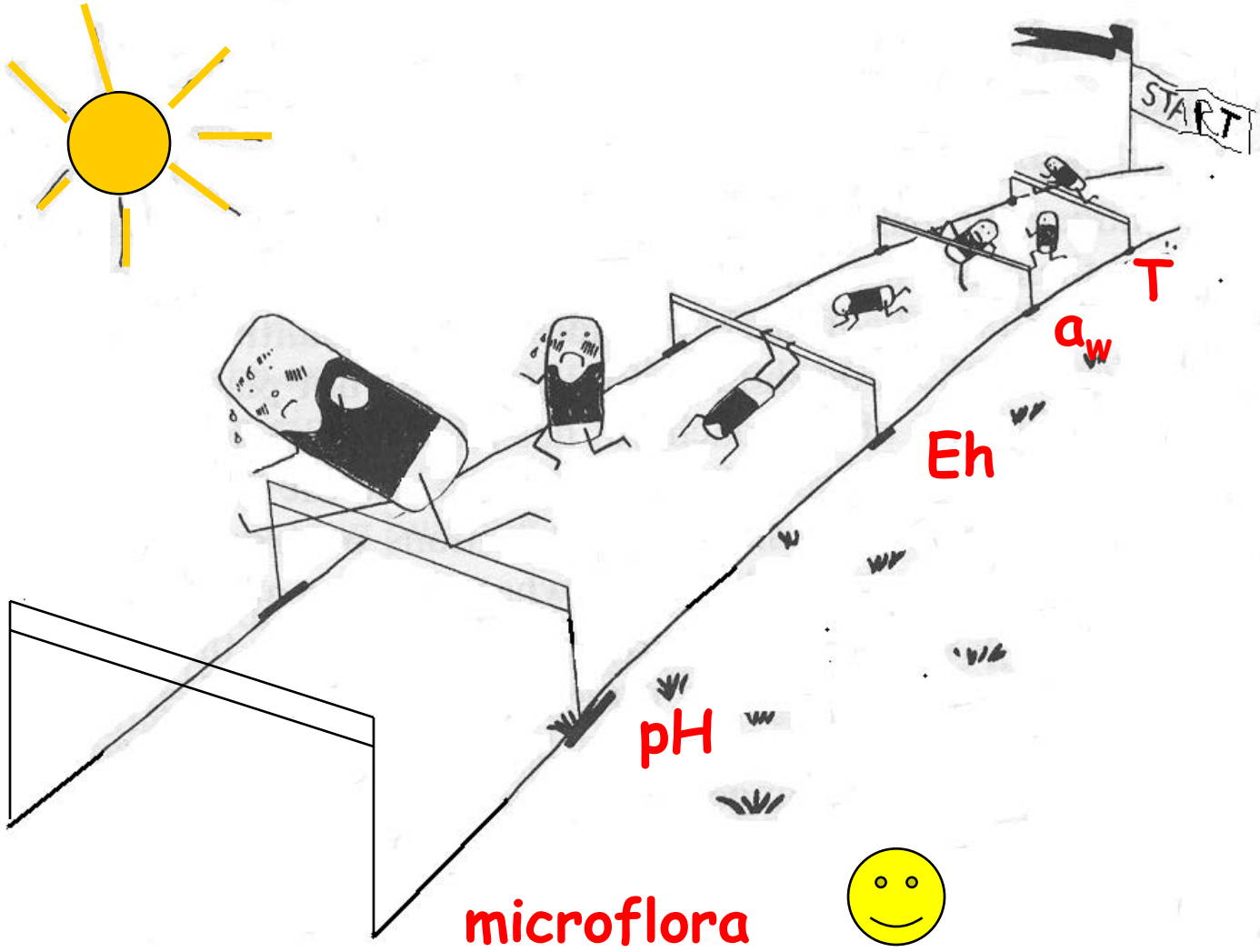




The hurdle effect



The hurdle effect



CNR- ISPA
Milano

Microflora in fermented food (cheese, sausage, salami)

We talk about million of micro-organisms per gram…….!

- RAW MATERIALS: milk, meat, (starter)
- TECHNOLOGY
- RIPENING CONDITIONS

- Microbiological control measures for reduction of the level of microbiological hazard and/or practical elimination of specific pathogens

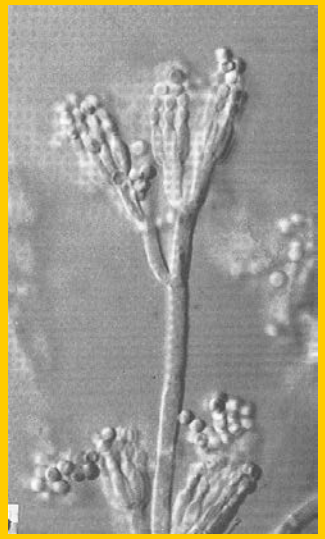
- Control of the natural ecosystem → { interaction, competition, inhibition }

dangerous to modify

CNR- ISPA
Milano

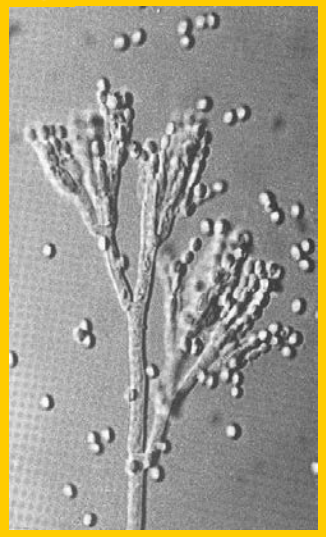
Natural ecosystem

Pitt J.I. et al., Fungi and food spoilage, BAP, London (1997)

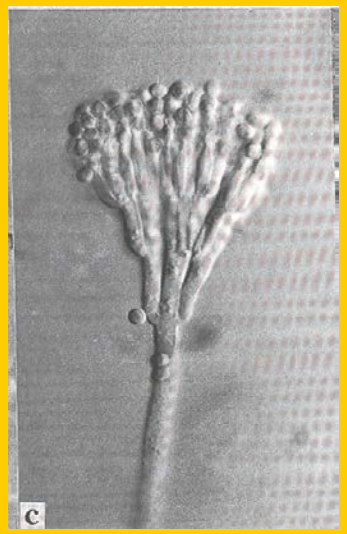


Penicillium chrysogenum

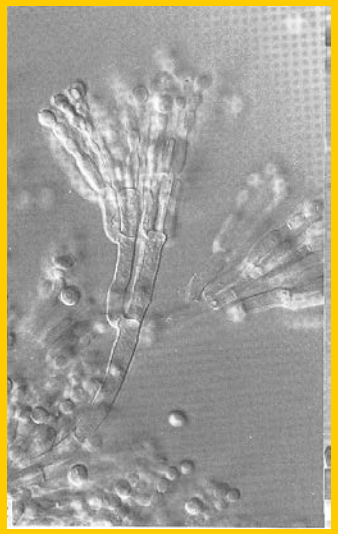
Penicillium commune



Penicillium griseofulvum



Penicillium crustosum



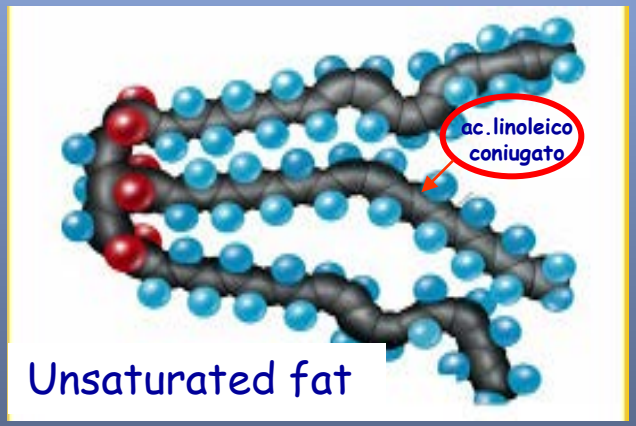
Penicillium aurantiogriseum

CNR- ISPA
Milano

- Hygienic quality
- Nutritional quality
- Sensorial quality

CNR- ISPA
Milano

FAT:
conjugated linoleic acid (CLA)



CLAs Properties

- Anti-cancer
- Antioxidant
- Immunomodulant
- Can help fight inflammation
- Can reduce body fat
- Can reduce the risk for cardiovascular disease

CNR- ISPA
Milano

Where?

- Cow meat	2,9-4,3
- Veal meat	2,7
- Lamb meat	5,6
- Milk	5,4-7,0
- Cheese	2,9-7,1
- Fish	0,3-0,6
- Pork meat	0,6
- Turkey meat	2,5
- Egg yolk	0,6
- Olive oil	0,2
- Sunflower oil	0,4

(Newbold *et al.* 2001) (Piva Prandini)

CNR- ISPA
Milano

benefits

limits

- MORE AROMA and FLAVOURS

- LOW TEMPERATURE
- MORE MOVEMENTS
- ENERGETIC REQUEST NOT SATISFIED

Italian PDO cheeses

(34)

Asiago

Bitto

Bra

Caciocavallo Silano

Canestrato Pugliese

Casatella Trevigiana

Casciotta di Urbino

Castemagno

Fiore Sardo

Fontina

Formai de Mut

Gorgonzola

Grana Padano

Montasio

Monte Veronese

Mozzarella di Bufala

Murazzano

Parmigiano Reggiano

Pecorino di Filiano

Pecorino Romano

Pecorino Sardo

Pecorino Siciliano

Pecorino Toscano

Provolone Valpadana

Quartirolo Lombardo

Ragusano

Raschera

Robiola di Roccaverano

Spressa delle Giudicarie

15

Stelvio

Taleggio

Toma Piemontese

Valle d'Aosta Fromadzo

Valtellina Casera

14

Raw or pasteurized milk

Raw milk

Pasteurized milk

Italian PDO cheeses (34+1)

Asiago

Bitto

Bra

Caciocavallo Silano

Canestrato Pugliese

Casatella Trevigiana

Casciotta di Urbino

Castemagno

Fiore Sardo

Fontina

Formai de Mut

Gorgonzola

Grana Padano

Montasio

Monte Veronese

Mozzarella di Bufala

Murazzano

Parmigiano Reggiano

Pecorino di Filiano

Pecorino Romano

Pecorino Sardo

Pecorino Siciliano

Pecorino Toscano

Provolone Valpadana

Quartirolo Lombardo

Ragusano

Raschera

Robiola di Roccaverano

Spressa delle Giudicarie

1

Stelvio

Taleggio

Toma Piemontese

Valle d'Aosta Fromadzo

Valtellina Casera

FORMAGGELLA DEL LUINESE

12

Only mountain pasture

Mountain pasture and plain

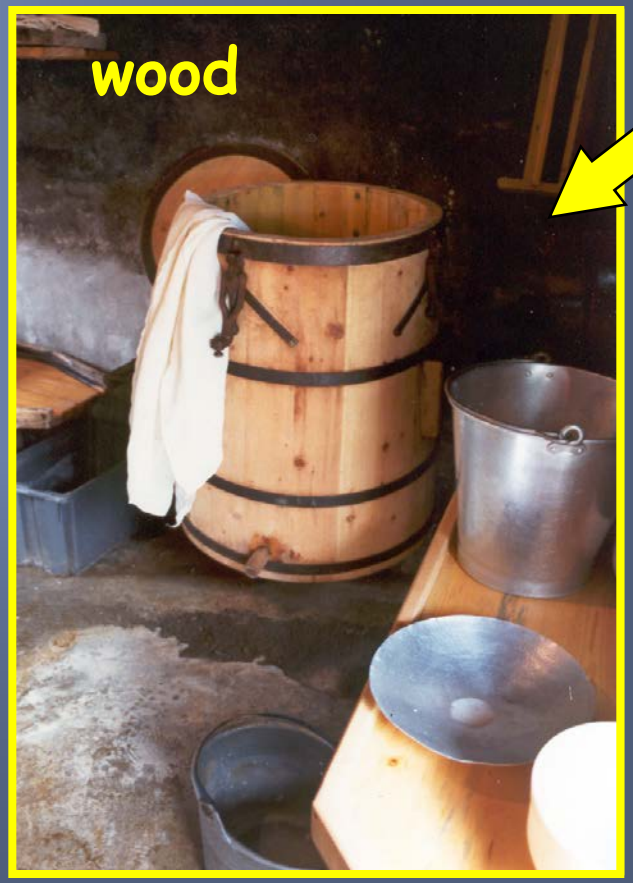
CNR- ISPA
Milano

Traditional products

CNR- ISPA
Milano

Ripening

CEE 92/46



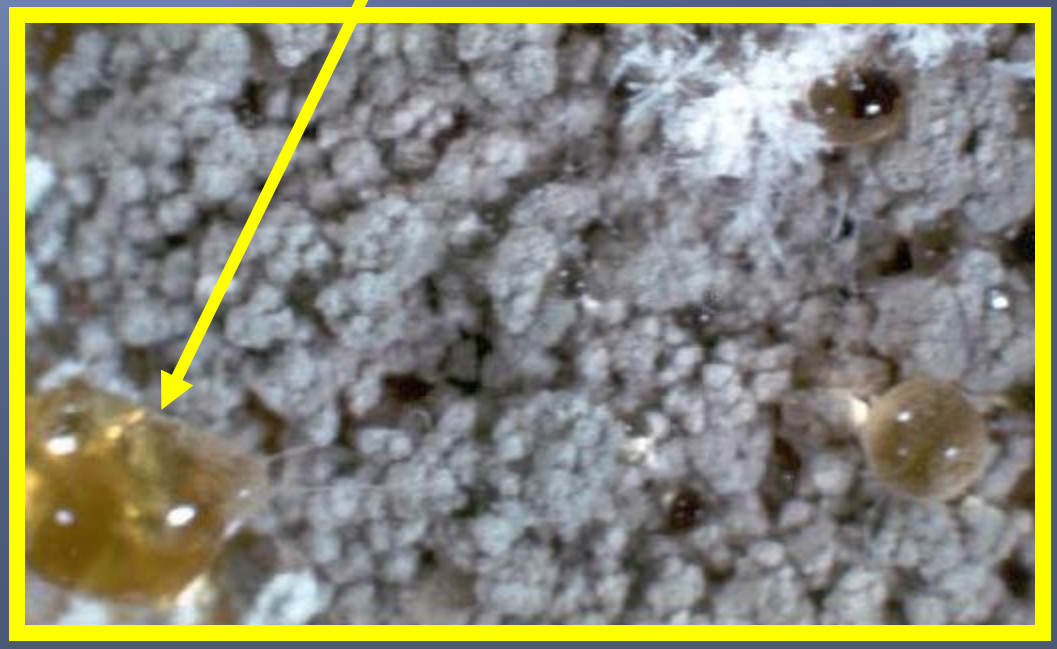
Equipments

Cleaning and hygiene in the mountain!

CNR- ISPA
Milano

??

To avoid !!!



CNR- ISPA
Milano

CNR- ISPA
Milano

Terpenes in grass

	α-pinene	camphene	β-myrcene	α-terpinene	limonene	eucaliptolo	γ-terpinene	thujone	camphor	linaloolo	bornyl acetato	mentolo	terpineolo	citronellolo	nerolo	geraniolo	β-ionone	farnesolo
Nocciolo	•		•		•	•	•	•		•		•	•	•	•	•	•	
Rovo	•		•	•	•		•			•			•	•	•	•	•	
Rosa	•		•	•	•	•	•		•	•	•		•	•	•	•	•	
Prato (pascolo)	•	•	•	•	•	•	•			•	•		•	•			•	
Ginestra	•	•	•		•		•		•	•	•		•		•	•	•	
Ginestra dei carbonaria	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
Alnus viridis	•		•		•	•	•	•	•	•	•	•	•	•	•	•		•
Molinia coerulea	•		•	•	•	•	•							•		•	•	

CNR- ISPA
Milano

Terpenes in milk and cheese

	α-pinene	camphene	β-myrcene	α-terpinene	limonene	γ-terpinene	linaloolo	bornyl acetato	mentolo	terpineolo	citronellolo	nerolo	geraniolo	β-ionone	farnesolo
1G	•		•	•	•	•	•	•		•	•	•		•	
1Gα	•		•	•	•	•	•	•		•	•	•		•	
1Gγ	•				•	•	•			•	•	•	•	•	
1F	•				•	•	•			•	•				
1Fα	•				•	•	•			•	•				
1Fγ	•				•	•	•			•	•				
1B	•									•	•	•			
1Bα	•									•	•	•			
1Bγ	•									•	•	•			
1A	•	•	•	•	•	•	•				•	•		•	
1Aα	•				•	•	•			•	•	•	•		
1Aγ6	•	•		•	•		•		•	•	•	•			
1Aγ7	•	•			•	•	•	•	•	•	•	•			
1Aδ	•				•	•	•			•	•	•	•		
1C	•		•		•	•	•			•				•	
1Cα	•		•		•		•			•	•	•			
1Cγ	•	•			•	•	•			•	•	•			
1I	•		•		•	•	•			•	•	•	•	•	
1Iα	•		•	•	•	•	•			•	•	•		•	•
1Iγ	•	•			•	•	•		•	•	•	•	•	•	•
2A	•			•		•	•			•	•				
2Aα	•			•		•	•			•	•				
2Aα	•	•		•	•	•	•			•	•	•			
2A'γ	•			•	•	•	•		•	•	•	•			
2A''γ	•		•		•	•	•		•	•	•	•			
2Gα	•				•	•	•			•	•				
2Gγ	•		•		•	•	•	•		•	•	•	•		
2B	•				•	•	•			•	•	•	•		

Factors affecting characteristics of mountain cheese

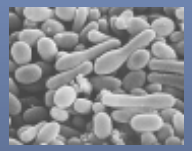
climate

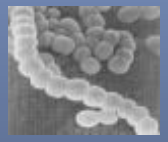
botanical composition of pasture

soil

chemical composition of ingested grass

autochthonous microflora

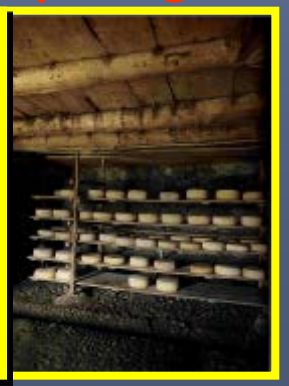




Cattle characteristic

Milk characteristics

technology and ripening



Organoleptic characteristics of ripened cheese

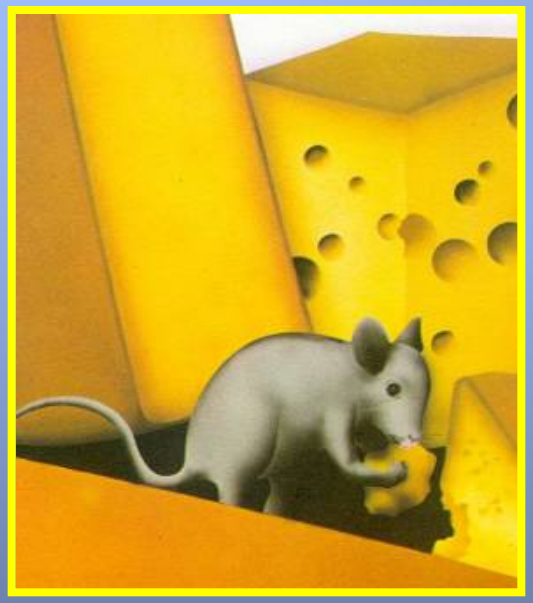
CNR- ISPA
Milano

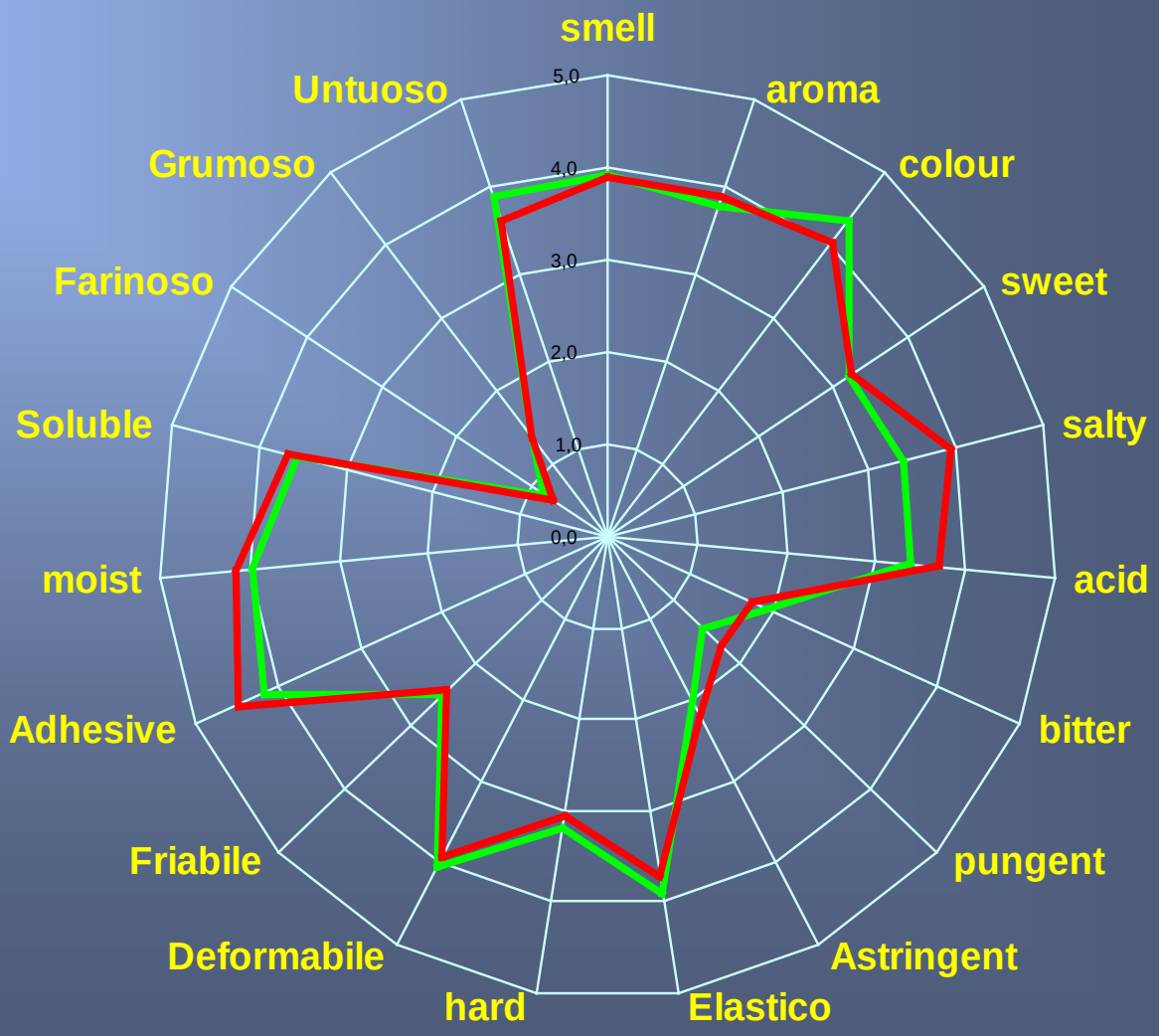
CNR- ISPA
Milano

- Hygienic quality
- Nutritional quality
- Sensorial quality

CNR- ISPA
Milano

SENSORIAL PROFILE

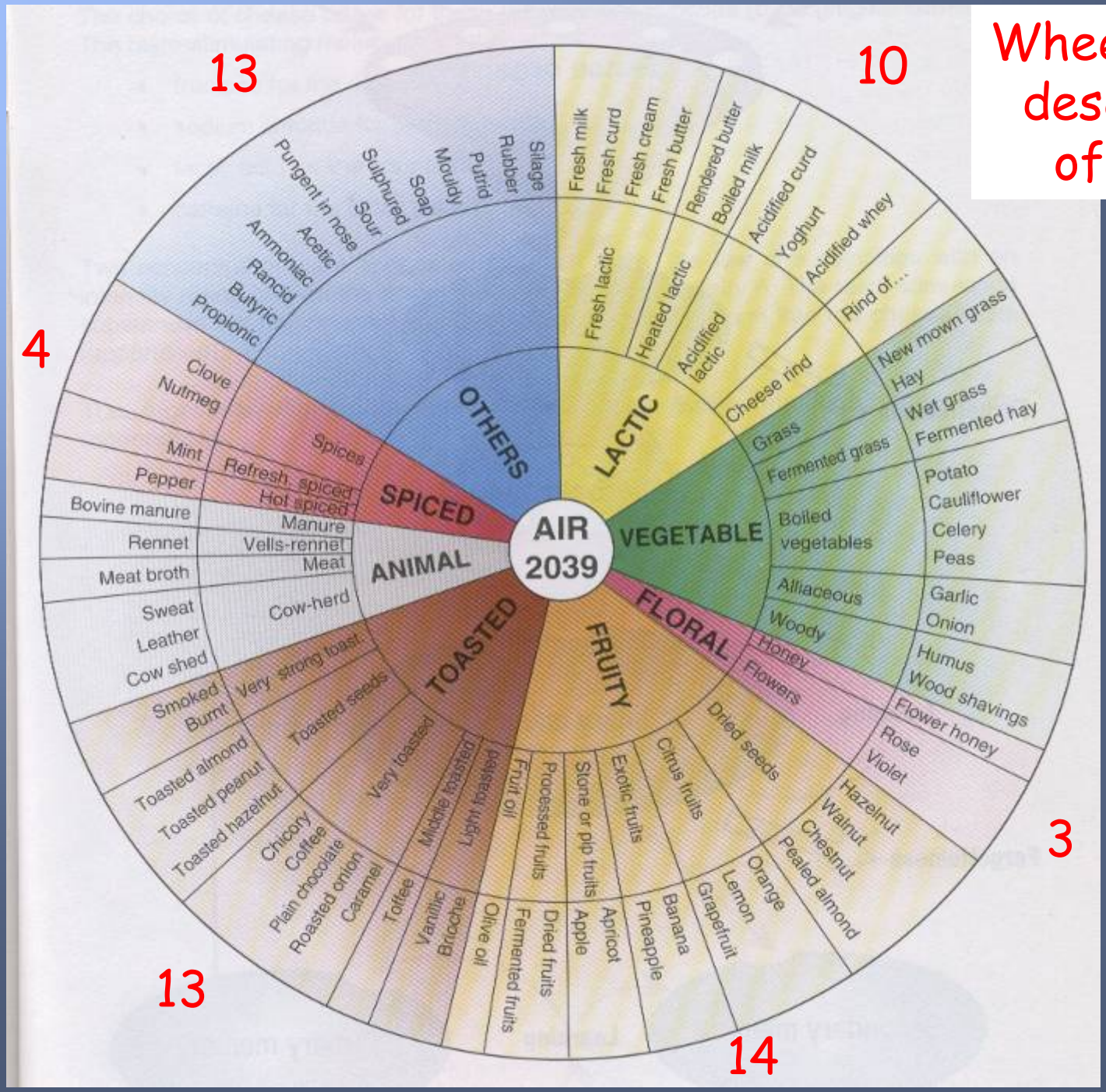




Sensorial profile of Bitto cheeses (70 days ripened)

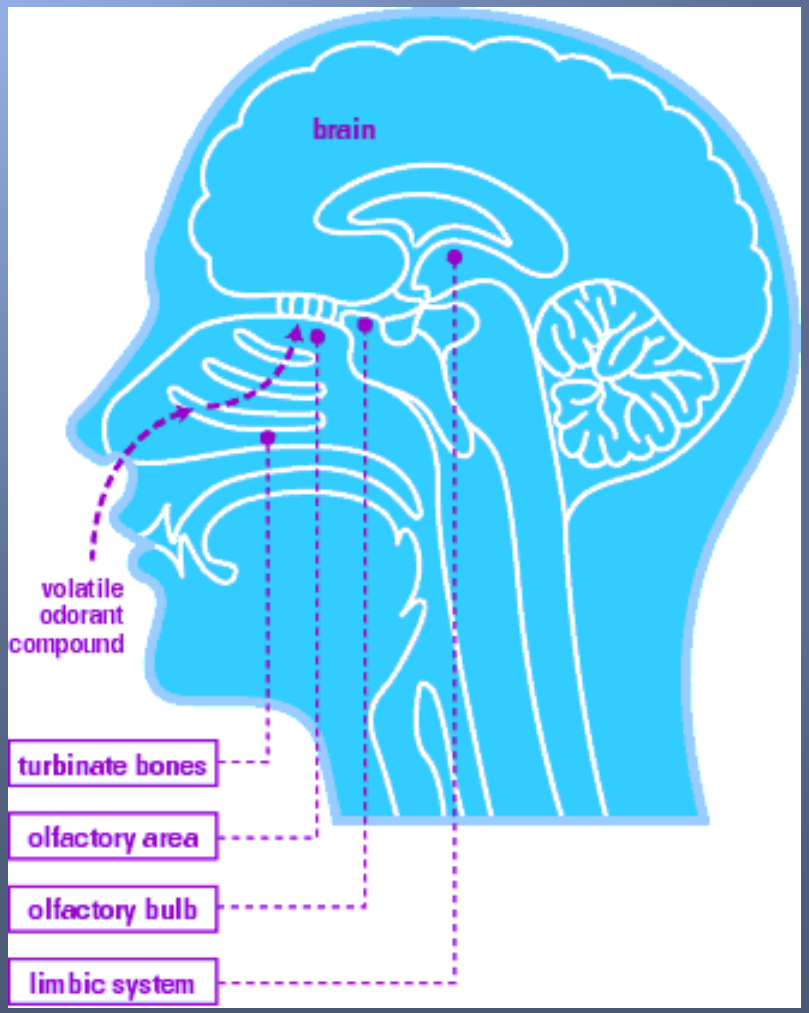
Wheel for the descriptors of aroma

75



CNR- ISPA
Milano

Volatile compounds



CNR- ISPA
Milano

How to valorize mountain area?

Specificity and peculiar sensory characteristics of traditional cheeses are strictly related to the high level of **biodiversity** of the indigenous microflora.

Over the centuries the technologies of these cheeses have selected complex bacterial ecosystems that represent a competitive environment for undesirable microorganims.

CNR- ISPA
Milano

Our focus…….

Characterization of autochthonous microbial populations of **raw milk cheeses** in order to:

1. obtain suitable selected cultures to guarantee high quality and safety of typical products
2. preserve the degree of microbial diversity in relation to its link with typicity
3. assess the possible risk or benefit connected to the presence of a high microbial biodiversity

CNR- ISPA
Milano

Studies of production chain for the characterization of typical Plain and Mountain foods

Identification and characterization of the factors contributing to define

- ♥ typicality
- ♥ geographic origin
- ♥ sensory quality

of the products of animal origin

Innovative techniques for

- ♥ control of PDO productions
- ♥ support of marks of origin

DENOMINAZIONE D'ORIGINE PROTETTA

CNR- ISPA
Milano

INDIVIDUATION AND CHARACTERIZATION OF ARTISANAL TIPICAL PRODUCTS

↓

ISOLATION OF STRAINS

↓

CHARACTERIZATION OF AUTOCHTHONOUS MICROFLORA

↓

PRODUCTION AND VALIDATION OF INNOVATIVE STARTER

↓

TIPICAL PRODUCT
HIGH LEVEL QUALITY

CNR- ISPA
Milano

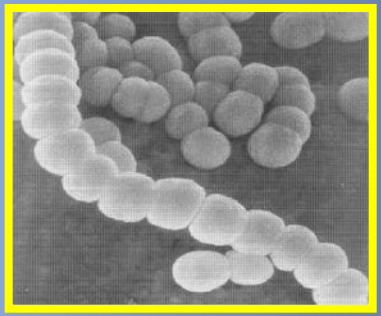
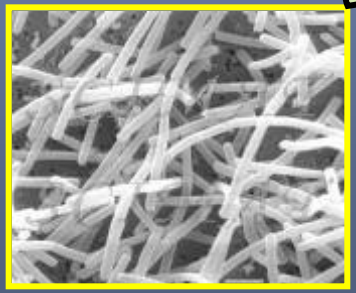
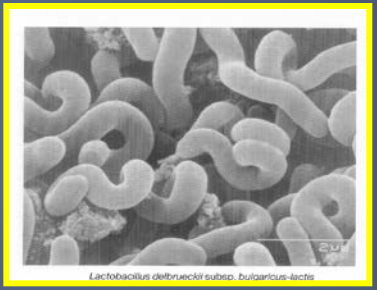
Conclusions

Milk and cheese of Alpine mountain can be considered

"good" quality

thanks to accurate, systematic, rigorous controls etc……
&
strong collaboration between farmers, cheesemakers, technicians, researchers, consumers

CNR- ISPA
Milano



autochthonous microflora (starter)